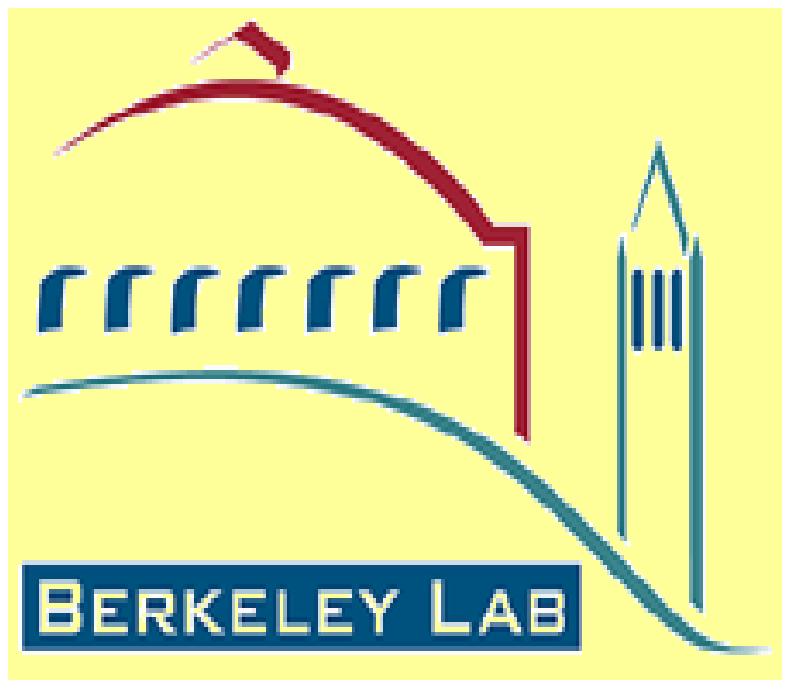


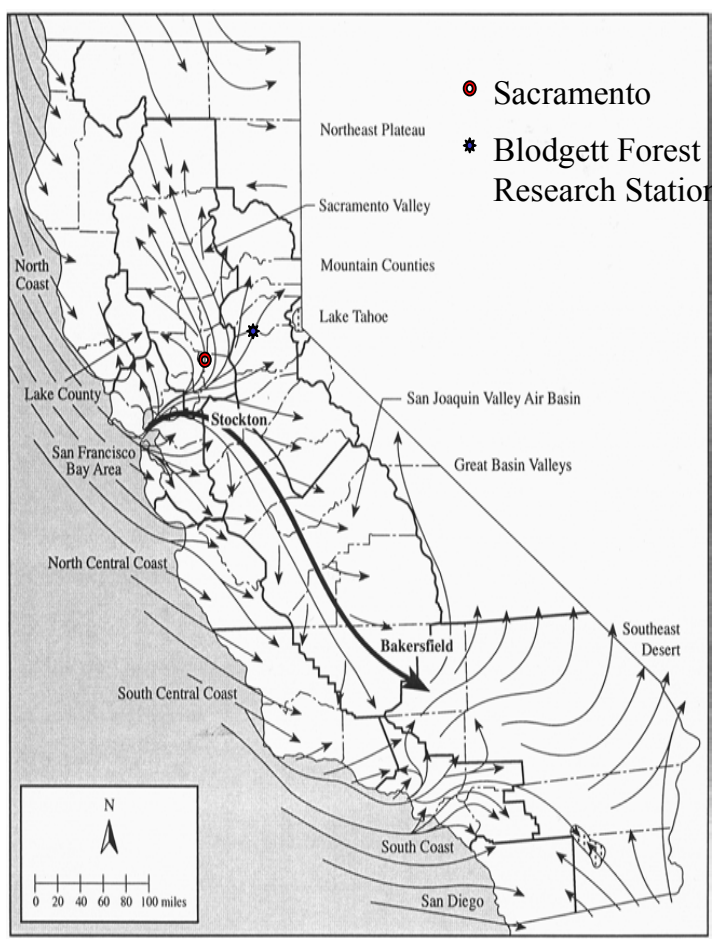
Fine Particle Formation and Processing in a California Pine Forest

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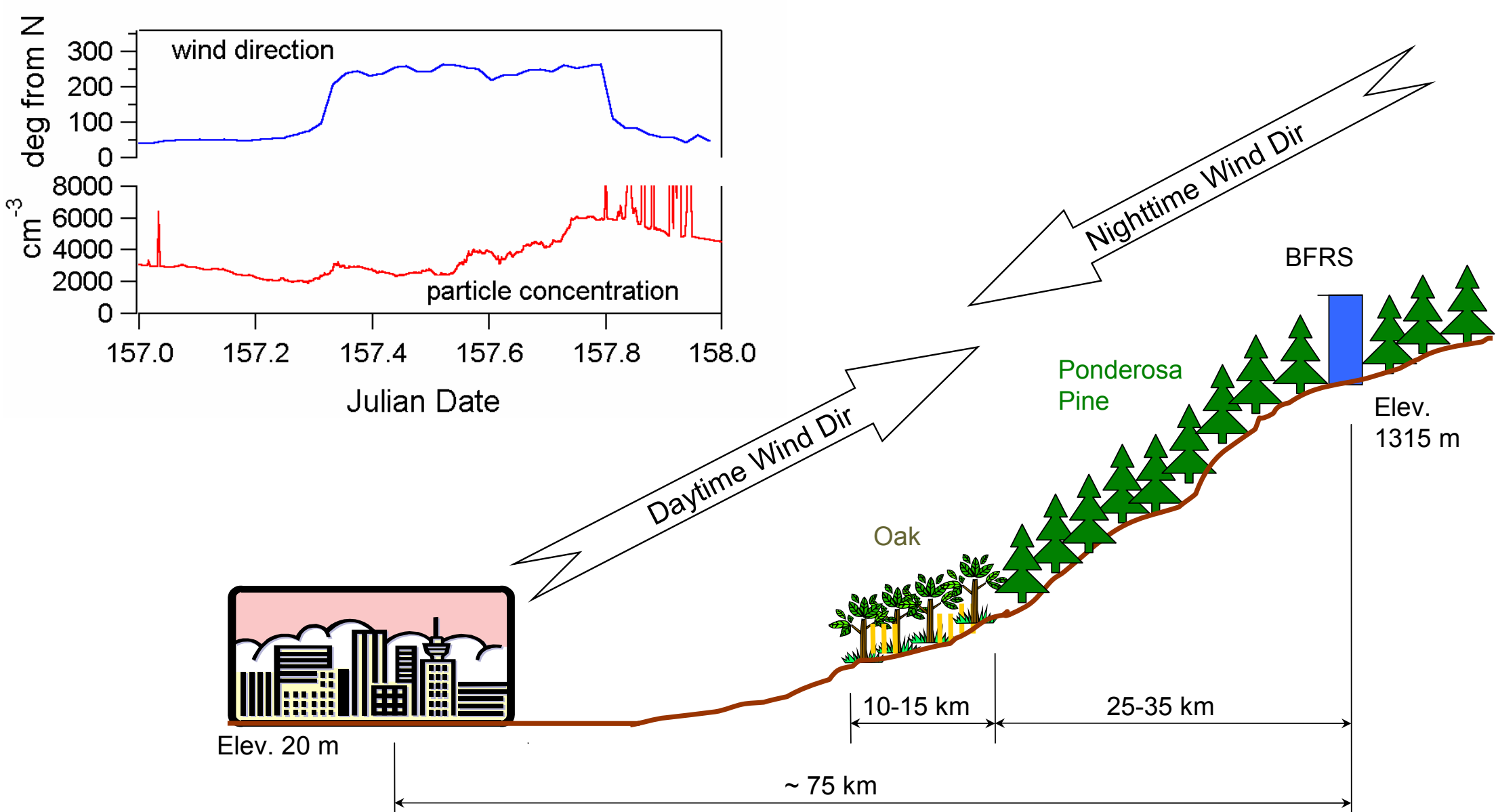
Overview

- Forested ecosystems emit significant amounts of volatile organic compounds (VOCs) which impact atmospheric photochemistry through ozone and aerosol production.
- To study biosphere-atmosphere exchange of ozone and VOCs and their effects on aerosol formation and processing, we have conducted a study at the Blodgett Forest Research Station in the Sierra Nevada Mountains of California.
- The research site includes automated instrumentation for the in-situ measurement of concentration and biosphere-atmosphere flux of VOCs, ozone, aerosol integrated and size resolved instrumentation, and meteorological variables.
- Our previous results have shown that total particulate loading is correlated with both biogenic (alpha-pinene and isoprene) and anthropogenic (toluene) concentrations.
- The addition of size resolved aerosol instrumentation enables further characterizing the interaction between anthropogenic and biogenic hydrocarbons and particle formation and growth.



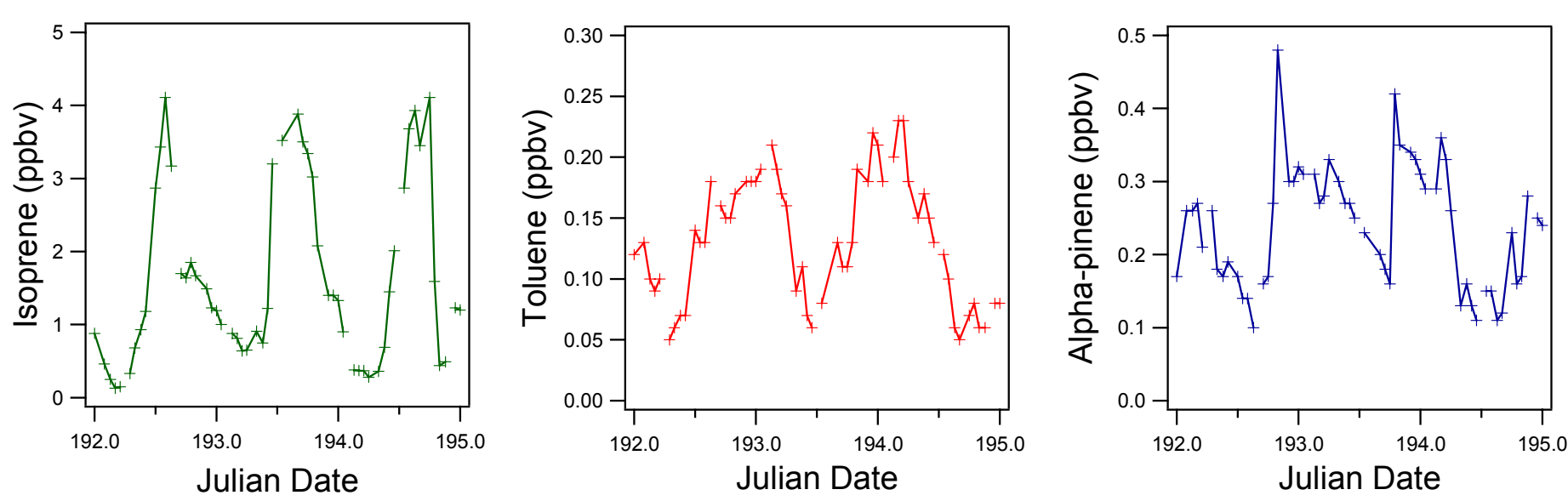
Blodgett Air Parcel Contributors

- Clean coastal inflow
- Urban outflow-Bay Area
- Agricultural outflow upwind of Sacramento
- Urban outflow-Sacramento
- Night-time inflow from Sierra Nevada



Site Characteristics

Typical VOC Patterns



- Toluene, an anthropogenic compound, increases rapidly around noon after the wind shifts direction and increases in speed, and remains high until cleaner air descends from above.
- Terpenes, represented by alpha-pinene, has a diurnal pattern with highest concentrations at night when vertical mixing is weakest and low concentrations during the day when mixing is more vigorous.
- Isoprene, a reactive VOC emitted from oaks, has maximum concentrations in the afternoon and minimum in the early morning.

Experimental Plan

Study Objective

- Characterize the formation of biogenic SOA under **actual conditions** in the atmosphere by:
 - Collecting **simultaneous** aerosol, VOC, and meteorological data
- Using measures of black carbon, CO, and other tracers to distinguish anthropogenic- and biogenic-influenced air masses
- Model relationships between particle size distributions, biogenic VOCs, and meteorological factors.



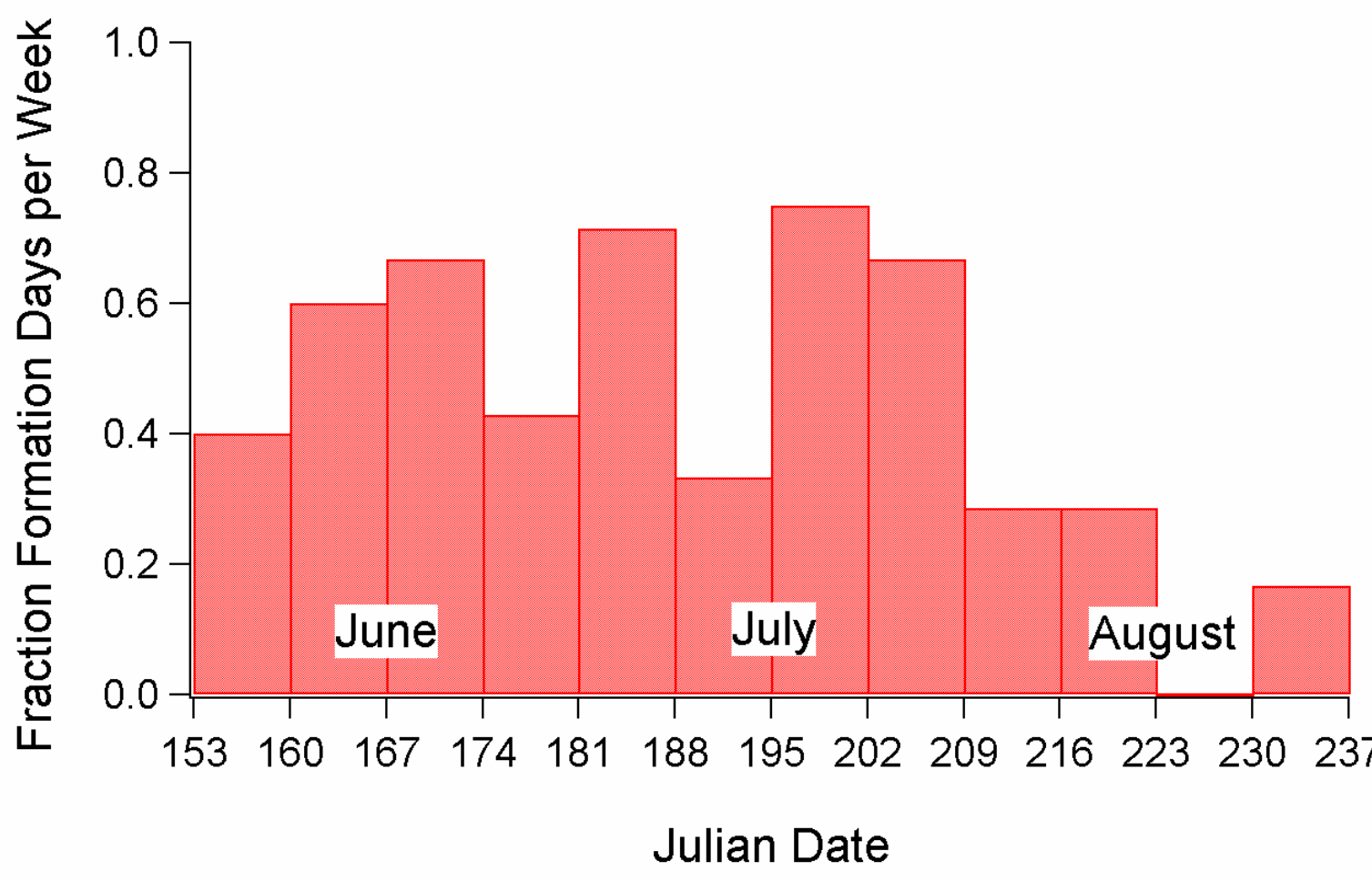
Aerosol Observations

Particle size distribution measurements indicate aerosol formation near the tower site. Before noon the peak in the particle size distribution is typically centered at ~80nm. Just after noon on many days, the formation of smaller, nuclei mode particles (<20nm) is observed. On occasion, this formation event occurs at the site. Most days, however, it appears that the particles were formed upwind before advecting to the site. Based on typical wind speeds and the size of the forest, it appears that the particle formation events occur in the forest. These particles are formed from a combination of biogenic processing of the anthropogenic air mass or solely by biogenic reactions. Particle formation events were observed on 29 days during the months of June, July, and August 2002. Observations by other investigators at other locations have suggested that particle formation events are preceded by a period of relatively particle-free air. We have observed formation both with and without the presence of a larger aerosol mode.

Effect of Temperature on Formation

Formation events were observed more often in June and July and less often in August 2002. The average maximum temperature on formation days was about 4 C cooler than on days without formation.

Average Daily Maximum Temperature (C)			
	June	July	August
Formation	21.1	24.3	23.0
No Formation	25.0	28.7	26.5



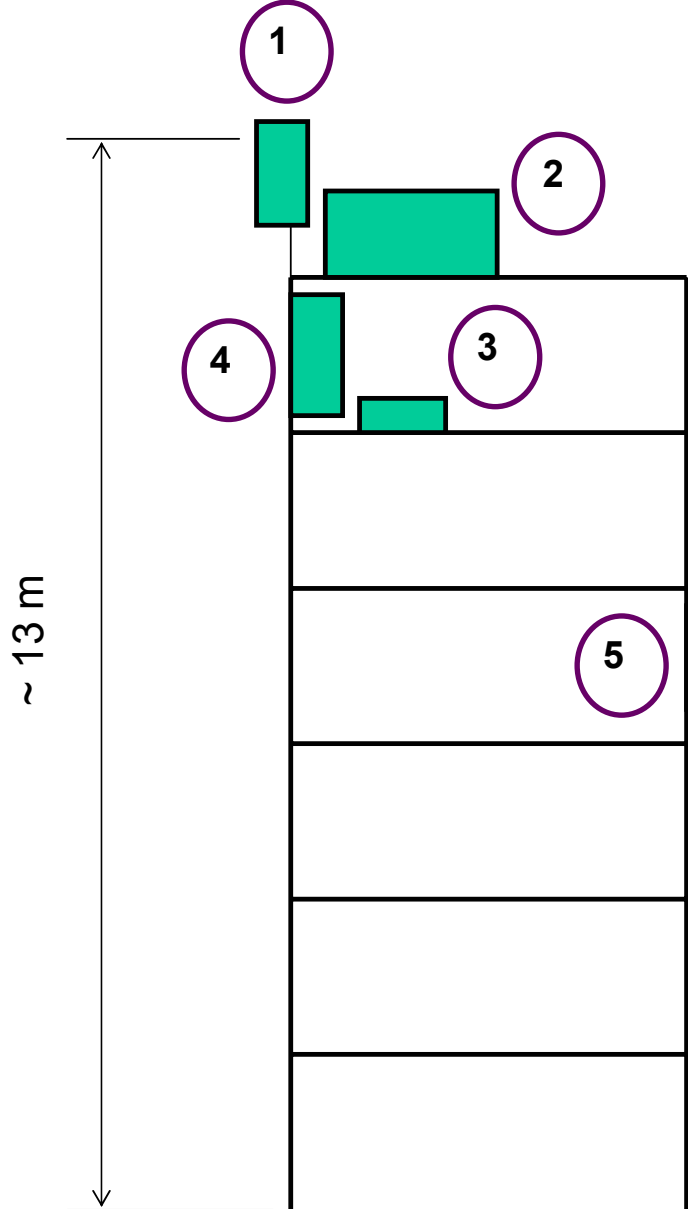
VOC and Meteorological Measurements

- CO, ozone, temp, RH, rain, PAR, wind direction and wind speed
- 12 VOCs of size C₂-C₁₀ measured with a gas chromatograph-flame ionization detector
 - Time resolution: 30 min avg each hr
 - Primarily biogenic: alpha-and beta-pinene, d-limonene, 3-carene, and isoprene
 - Biogenic oxidation products: Methacrolein and methyl-vinyl ketone
 - Primarily anthropogenic: Toluene

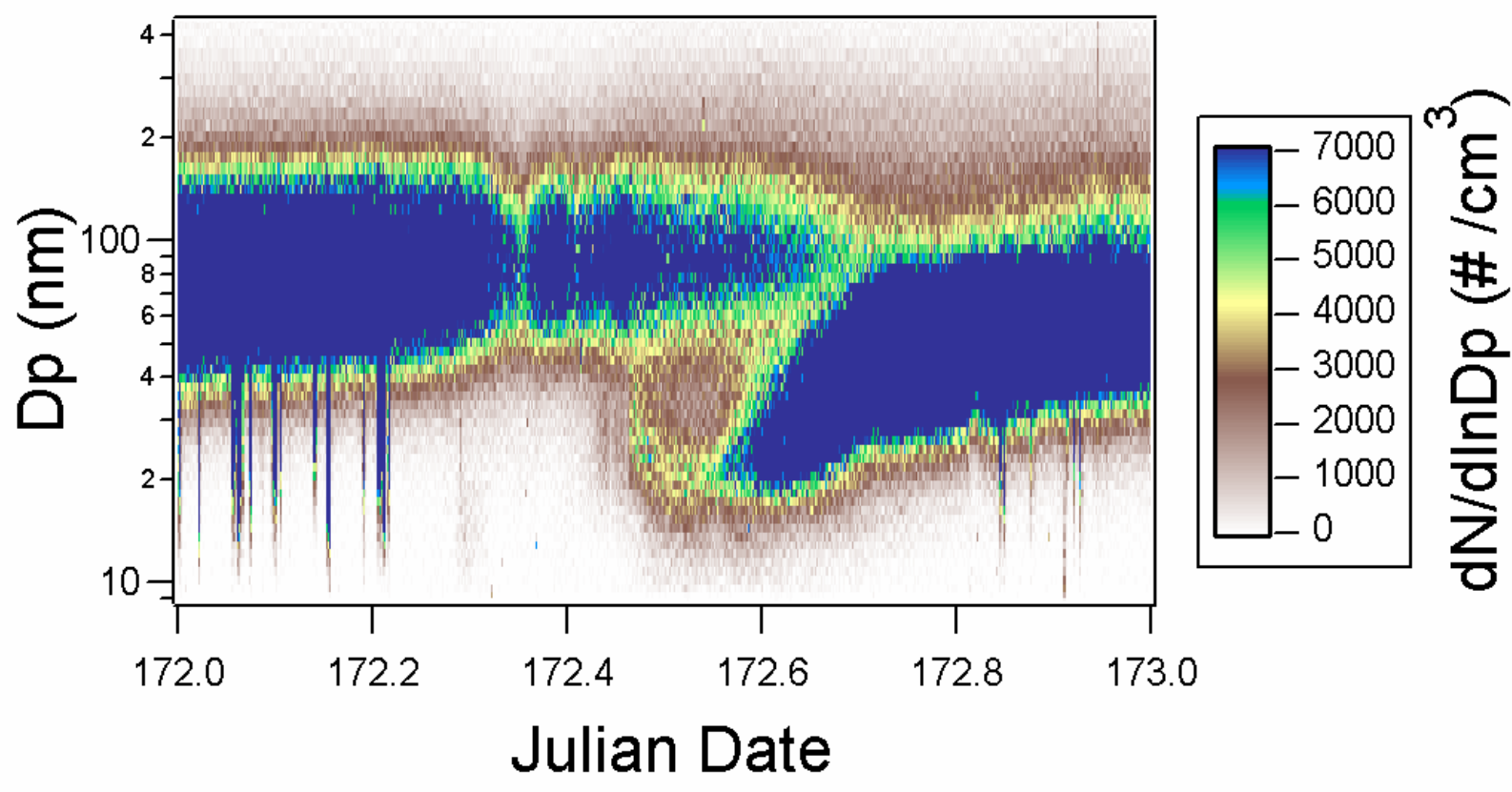
Site Description

- Heavily forested site on western slope of Sierra Nevada, CA at an elevation of 1315 m
- 38.9° N, 120.6° W; elev. 1315 m-75 km NE of Sacramento
- Primary species surrounding the site is ponderosa pine which is a known monoterpene emitter
- Consistent wind patterns
 - Carried both biogenic and anthropogenic emissions during the day and primarily biogenic emissions at night
- Measurements made Summer and Fall 2001 and Spring through Fall 2002

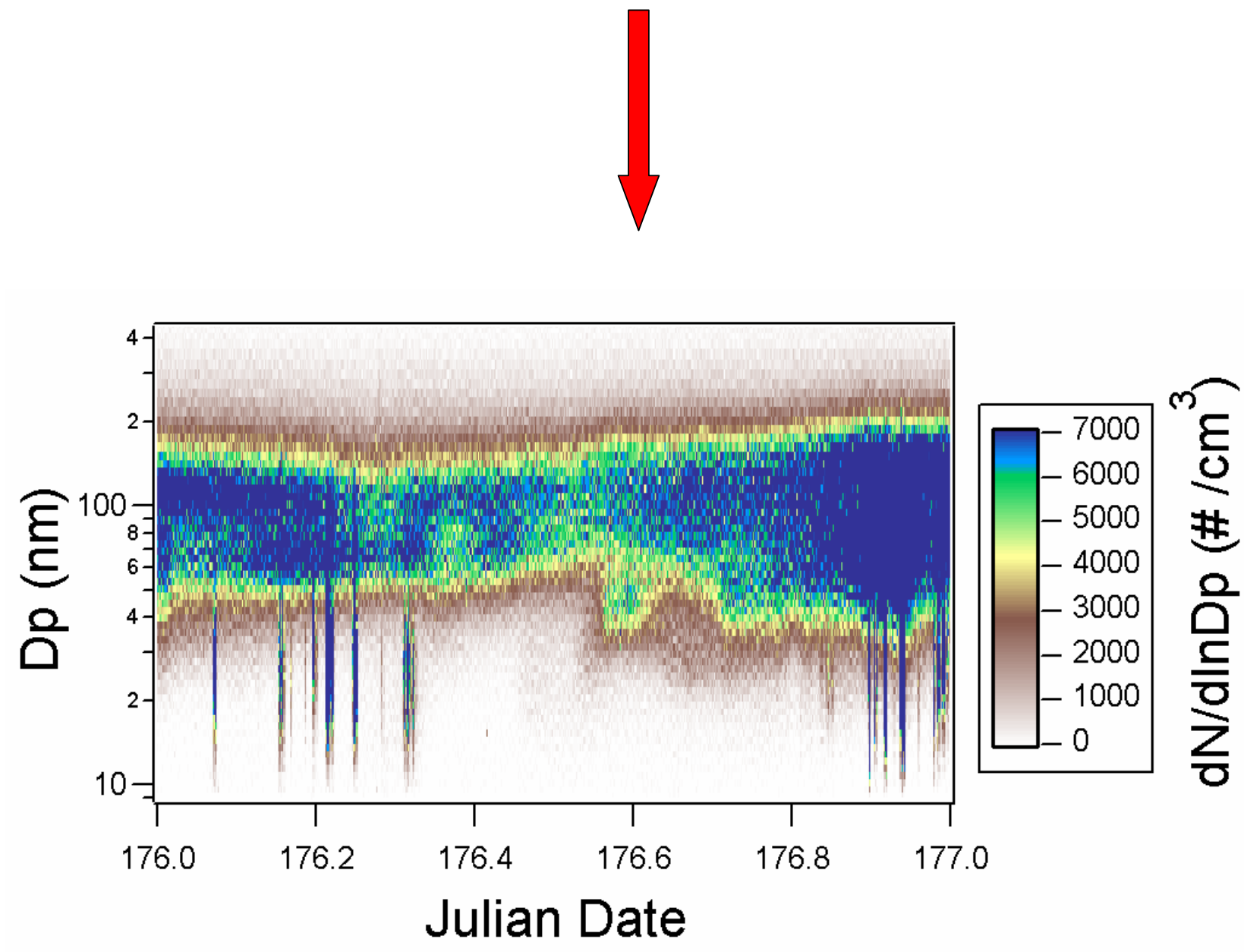
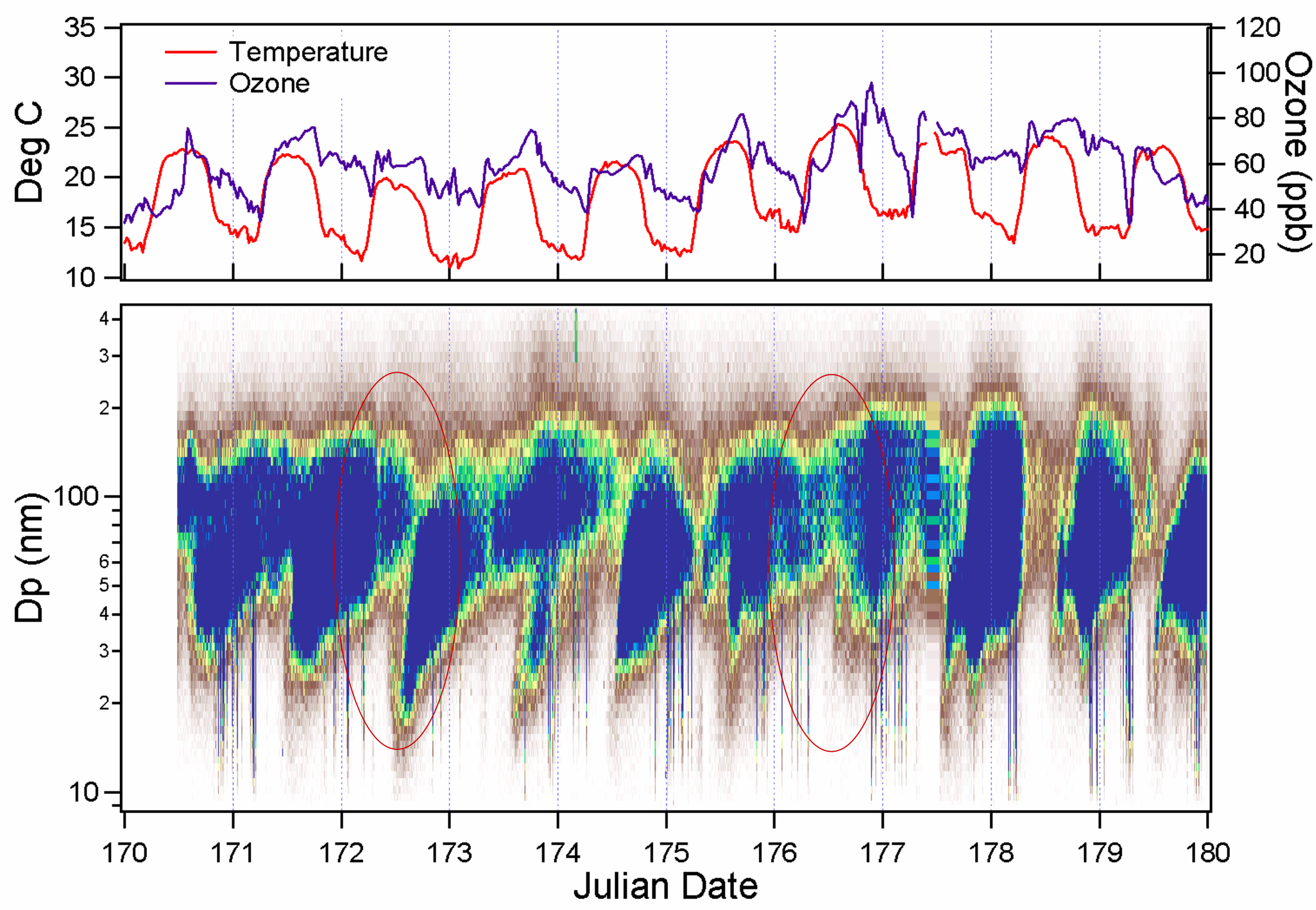
Aerosol Instrument Placement on Tower



- 2.5 µm cut-point cyclone inlet
- Aethalometer (Andersen RTAA-900) Black Carbon Time resolution: 5 min
- Condensation Particle Counter (TSI 3022A) Total Particle Counts Time resolution: 2 min
- SMPS - Particle Size Distribution (10 – 450 nm) Time resolution: 1 min
- Nephelometer (Optec NGN-2) Scattered Light Time resolution: 2 min



- Overnight particle size distributions are most often centered at ~80 nm. Just after noon on many days, smaller nuclei mode particles (<20 nm) appear at the site (Figure Above).
- These aerosol formation events are not typically observed on warmer days (Figure Right).



Conclusions

- On many days afternoon formation of small nuclei mode particles (<20 nm) was observed.
- Formation events were strongly correlated with lower temperature, with fewer observed events occurring later in the summer.
- Particle formation events often occurred in the presence of a larger aerosol size mode.
- A future goal is to make simultaneous measurements of mono- and sesqui- terpenes and their oxidation products in concert with chemically resolved particle measurements.

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